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END OF SEARCH HISTORY

L11: Entry 3 of 3 File: USPT Feb 24, 2004

DOCUMENT-IDENTIFIER: US 6696980 B1
TITLE: Cockpit instrument panel systems and methods of presenting cockpit instrument data

Brief Summary Text (6):
Modem commercial/private aircraft, as well as older aircraft, include a myriad of instrumentation panels having controls and displays used to present information related to the controls. The controls and the displays are operated, viewed, and interpreted by a pilot during flight of an aircraft. Some of these controls are used for assisting the pilot with navigation, such as a horizontal situation indicator, an attitude indicator, and the like. Other controls are used to permit radio communication with other pilots in the air or with air traffic controllers during flight. Still more controls, in recent years, are used to assist in navigation using Global Positioning Satellite (GPS) systems associated with satellite technology. Furthermore, transponder controls permit the aircraft to be uniquely identified and the aircraft's altitude communicated to air traffic controllers during flight.

Brief Summary Text (7):
For a neophyte, the quantity of controls and display panels contained within the cockpit of an aircraft is daunting. Even experienced pilots must stay focused in order to access various controls within the cockpit and interpret information presented on various displays throughout the cockpit. As a result, pilots must continually scan a plurality of available displays for flight information at any particular moment in time during flight.

Brief Summary Text (10):
As is apparent to those skilled in the art, a pilot and copilot must remain alert and focused on controls and displays at critical points during the flight, such as takeoffs, landings, inclement weather, emergencies, or equipment malfunctions. Thus, pilots are required to have many hours of training to master the controls and displays within the cockpit before receiving the proper certification to fly an aircraft. This is especially true with larger commercial aircrafts. Moreover as a result of the heightened mental acuity required during flight, many federal regulations also restrict the amount of time a pilot is permitted to fly in any given day in order to ensure the pilot remains alert during flight.

Detailed Description Text (3):
In the present invention, improved multifunction displays (MFDs) are provided. As used herein, a MFD is used broadly to include graphical user interface based (GUI-based) displays with integrated presentation data presented thereon using a variety of views. The views are configured on the MFDs to provide ready access to flight information data. In some embodiments of the present invention the use of the term MFD is employed in connection with or to refer to a primary flight display (PFD). In some embodiments of the present invention the use of the term MFD is employed in connection with or to refer to a navigation display (NAV display). Additionally, in some embodiments, multiple MFDs are included such that a first MFD is principally used as a PFD and a second MFD is principally used as a NAV display. In such

embodiments, the second MFD or NAV display is in compliment to the PFD. In the present invention, multiple MFDs can be stacked one upon the other, or alternatively arranged side by side. Further, in some embodiments an MFD is adapted to include audio capabilities. As one of ordinary skill in the art will appreciate upon reading this disclosure, the flight information data which is presented on such MFDs can differ based on the aircraft type, e.g. frame and engine type.

Detailed Description Text (4):
In the invention, a "bezel" is provided as part of the MFDs. Typically, the bezel is the framed perimeter that surrounds a display, but is not part of the display itself. Further as used in this application, control data and instrumentation data, including flight information data, refer to data received by controls coupled to input devices, such as communication and navigational input devices, and data received from various equipment and sensors, such as the aircraft engine, fuel, airspeed, altitude and attitude sensors. For example, navigational and communication controls tune navigational devices (e.g., VLOC receivers, radios, and the like) within the aircraft and permit software operating on a processing device to receive and process the communication and navigational data collected by such devices. Equipment and sensor instrumentation facilitate the presentation of data relating to such parameters as aircraft engine, fuel, airspeed, altitude and attitude status.

Detailed Description Text (5):
In the present invention, this data can be operated on by software to generate one or more dynamic images on the GUI of a MFD display. As one of ordinary skill in the art will understand upon reading this disclosure, the display is capable of presenting text or graphical information. In some embodiments, the display provides image or video data. In one example, the GUI depicts a present movement, path and/or projected destination of an aircraft relative to locations on the ground along with airspeed, altitude, attitude and engine status data. As one skilled in the art will appreciate, input devices such as communication and navigation controls include settings such as a current radio frequency, channel, and the like.

Detailed Description Text (7):
FIG. 1 illustrates an example of one cockpit instrument panel 100 according to the teachings of the present invention. It is readily appreciated that the data and labels presented within panel 100 are presented by way of illustration only. The panel includes a bezel 150 having four sides namely, a left side 151, a bottom side 152, a right side 153, and a top side 154. Further the panel 100 includes a display 140 enclosed by the four sides (e.g., 151, 152, 153, and 154) of the bezel 150. However, the invention is not so limited, and in some embodiments bezel 150 can be oriented on three or fewer sides of the display 140. As one skilled in the art will understand upon reading the disclosure, the scope of the present invention includes a bezel 150 proximately located to the display 140 on panel 100. The display 140, in more embodiments, is a PFD and is any GUI-enabled device capable of presenting text, image, graphical, or video data. Further, the PFD in some embodiments is adapted to include audio capabilities. These audio capabilities can include voice communication settings, audio quality settings, audio volume settings, and the like. Moreover, the bezel 150 has affixed thereon a number of navigational input controls, such as VLOC 110 which is a control for VHF Omnidirectional radio range often referred to as VOR.

Detailed Description Text (8):
Further, the bezel 150 has affixed thereon communication input controls, such as COM 120 permitting radio communications with air traffic controllers and/or other pilots in the air. Also, the bezel 150 has affixed thereon transponder input controls, such as numeric touch pad 130, XPDR control 132, IDENT control 136, and VFR control 134. In this way, the pilot can use the numeric touch pad 130 to enter a unique identifying number required by the air traffic controllers to identify the

pilot's aircraft. In FIG. 1, the text string "1200 ALT IDT" 141 presented on the display 140 includes the aircraft's transponder identity information. The IDENT 136 control permits the aircraft to uniquely be identified on an air traffic controller's display when requested. For example, if the pilot presses the IDENT 136 control during flight, then the air traffic controller identifies the pilot's aircraft as a uniquely distinguishable and identifiable item on the controller's display. Further, the XPDR 132 control selects the mode of operation for transponder communications.

Detailed Description Text (9):
In some embodiments, the panel 100 includes a GPS control 112 for satellite navigation capabilities. In other embodiments, the panel includes autopilot controls (not depicted). Further, in some embodiments text messaging controls or video telecommunication controls are affixed on the bezel. In this way, a numeric touch pad 130 includes alpha characters and/or symbol characters on each touch pad (not depicted) along with a numeric depicted in FIG. 1. As one skilled in the art will appreciate, this permits a pilot to send and receive text messages from other pilots, the Internet, authorities, air traffic controllers, or other electronically interfaced sources if an appropriate wireless network connection is established. Further video controls, in some embodiments, permit the pilot to view the cabin of the aircraft for disturbances or for the air traffic controllers to view different locations within the cockpit and/or cabin of the aircraft.

Detailed Description Text (11):
Additional controls affixed to the bezel 150, in some embodiments, permit increased integration within the cockpit and provide customized presentations of data on display 140 of panel 100. For example, overlay controls 114 located on the bottom side 152 of the bezel 150, permit the pilot to adjust the main display 140 by overlaying graphical data related to weather (e.g., labeled as WX in FIG. 1), traffic, and terrain. Further, in some embodiments, the pilot customizes the display 140 by creating one or more insets within the display 140 such as inset display 142.

Detailed Description Text (12):
Display 140, in some embodiments, include a top portion 143 having control settings and readings depicted horizontally across the vertical top portion of the display 140. For example, communication channel 1 represented as COM1 is set to frequency 118.90 in FIG. 1. Communication input control settings include, in some embodiments, frequency data, channel data, and the like. Moreover, the display 140 can include one or more inset displays, such as display inset 144 depicting an example of the aircraft's vertical assent and vertical velocity. Display marker 145 presents preselected altitude data indicating how high the pilot wants the plane to climb. Marker 146 includes a preselect tag indicating the desired vertical speed, and tag 147 indicates the current vertical speed of the aircraft during the assent. Marker 148 shows the glide scope or VNAV deviation Finally, marker 149 indicates the altimeter setting.

Detailed Description Text (14):
In some embodiments, the display 140 is operable to present aircraft equipment data, such as fuel flow, engine temperature, oil temperature, oil pressure, fuel quantity, RPMS, electrical load, outside air temperature, outside air pressure, and the like. Also, in some embodiments the panel 100 includes a bezel 150 having audio controls affixed thereon. In this way, nearly all controls which the pilot needs to access during flight are proximate to the display 140 which the pilot views. The display 140 is a PFD or MFD, which simultaneously presents various inset views and settings associated with the controls in a single display 140.

Detailed Description Text (16):
FIGS. 2A and 2B illustrate one cockpit instrument panel system according to the teachings of the present invention. The system includes a first instrument panel

210 having a first display 214 enclosed within a first bezel 212. Navigational controls, communication controls, and transponder controls are affixed on the first bezel 212. The first display 214 is operable to present navigational data, communication data, and transponder data associated with the controls of the first bezel 212. Moreover in some embodiments, the display 214 is operable to present aircraft equipment data 215, such as fuel flow, engine temperature, oil temperature, oil pressure, fuel quantity, electrical load, outside air temperature, outside air pressure, and the like. Equipment data 215 is optionally presented within display 214 by activating an equipment display control 211.

Detailed Description Text (18):
In some embodiments, audio controls are affixed to either the first bezel 212, the second bezel 222, or both bezels (e.g., 212 and 222). Further, in some embodiments either bezel (e.g., 212 or 212) or both bezels (e.g., 212 and 222) include GPS controls, autopilot controls, messaging controls (if desired), video controls (if desired), or others.

Detailed Description Text (21):
Further as is readily apparent to those skilled in the art, the navigational controls are associated with navigational devices within the aircraft, the communication controls are associated with communication devices within the aircraft, the transponder controls are associated with a transponder device within the aircraft, and equipment controls (e.g., 211) are associated with equipment devices within the aircraft. As will be readily appreciated by those skilled in the art, each device within the aircraft is easily interfaced to the controls and affixed in duplicate to both bezels (e.g., 212 and 222), which are adjacent to both displays (e.g., 214 and 224).

Detailed Description Text (30):
As one skilled in the art will appreciate, a single embodiment can include all the aforementioned data and controls, therefore the embodiments are not intended to be exclusive of one another. All controls are affixed to a bezel or otherwise proximately located to a single display. The proximity of the controls to the display provides improved ergonomic and ease of use capabilities to an operator utilizing method 400. Moreover, the integration and proximity of the controls to the display decrease physical space requirements within a cockpit of an aircraft.

Detailed Description Text (35):
As previously discussed, by configuring the circuit panels (e.g., 511-520) behind a rear surface of the bezel and/or behind a rear surface of the display 530 within panel 500 significant physical space can be reduced within an aircraft having panel 500. Physical space is at a premium with modem aircraft and the present invention provides improved space utilization, thereby freeing previously occupied physical space within the aircraft to be used for additional equipment, sensors, or devices as desired. Moreover, the proximity of the controls to the display 530 provide improved ergonomic and ease of use features to the operator of the panel 500.

Detailed Description Text (40):
The above cockpit instrument panels, systems and methods have been described, by way of example and not by way of limitation, with respect to improving input controls and pilot delivered display data for an aircraft. That is, the instrument panels, systems, and methods provide for better integrated control, access, and presentation of information within the cockpit. The integration and placement of controls and displays of the present invention provide for improved flight safety by alleviating the physical dexterity and mental acuity required with existing cockpit instrument panels. Moreover, the integration and placement of controls and displays of the present invention reduce physical space requirements within a cockpit of an aircraft.

CLAIMS:

7. The instrument panel of claim 1, wherein the display further simultaneously displays aircraft equipment data.

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L7: Entry 10 of 10 File: USPT Feb 3, 1998

DOCUMENT-IDENTIFIER: US 5714948 A
TITLE: Satellite based aircraft traffic control system

Abstract Text (1):
A satellite based air traffic control (ATC) system includes an aircraft unit on an aircraft and an ATC facility. The aircraft unit includes an AARTS processor, GPS receivers or other satellite receivers, a comparator for comparing the GPS data, a two-way radio, and a transmitter and receiver for communicating information and data over a data link with the ATC facility. The ATC facility includes an ATC computer, a two-way radio, a display for displaying aircraft, and a transmitter and receiver for communicating information and data over the data link. The aircraft transmits aircraft identification information, GPS data, aircraft status information, and a transmit detect code to the ATC facility to allow the ATC to track the aircraft and identify the aircraft communicating on two-way radio. The traffic control system and a flight control system utilizing GPS may be used for aircraft in the air and on the ground, and may be used for ships, boats, automobiles, trains or railroads, and aircraft.

Brief Summary Text (3):
Present air traffic control systems consist of a network of terminal area and enroute surveillance radar systems. These systems consist of both primary and secondary radar systems and computers that display usable data for the control of air traffic in the national and international airspace systems.

Brief Summary Text (5):
Secondary radar, known as the Air Traffic Control Radar Beacon System (ATCRBS), utilizes cooperative equipment in the form of radio receiver/transmitter (Transponder). Radar pulses transmitted from the searching radar transmitter interrogate the airborne transponder. In response to receiving the interrogating signal from the radar, the Transponder transmits a distinctive signal back to the Radar Beacon System's antenna. For example Delta flight 195 to Dallas (Dal195) is requested to squawk "4142," resulting in the aircraft transponder being dialed to code "4142." The computer at the air traffic control (ATC) facility is preprogrammed to understand that transponder code "4142" corresponds to Dal195. The signal transmitted by the Transponder is typically coded to provide both aircraft altitude and aircraft identification data (4142) for processing by the air traffic controller's computer for display on the air traffic controller's radar scope. The aircraft's transponder is connected to an altitude encoder which encodes altitude data based on the altitude of the aircraft as determined from the aircraft altimeter. In addition, the aircraft's speed is presently determined by the ATC computer by measuring the time and distance differences from subsequent transmissions of the Transponder. The aircraft transponder code, altitude, and speed may be displayed on the controller's radar screen.

Brief Summary Text (6):
However, present radar-based air traffic control systems suffer from a number of disadvantages and drawbacks. Radar systems, even when used in conjunction with secondary radar, provide limited range and accuracy in the determination of the

location and altitude of an aircraft. The range of radar is inherently limited due to obstacles in the line of sight of the radar, curvature of the earth, atmospheric conditions, etc. Search radar has a range of approximately 300 to 350 nautical miles, while terminal radar is utilized only for about 30 nautical miles. Radar coverage is not available in many areas of the world, and is not available at all altitudes in the United States.

Brief Summary Text (10):
Alternative ATC systems have been proposed that would use the global positioning satellites (GPS). Such a proposed alternative is discussed in chapter 12 of Logsdon, The Navstar Global Positioning System, Von Neistrand Reinhold (1992). In The Navstar Global Positioning System, Logsdon discusses the proposed use of GPS receivers on board aircraft, wherein the aircraft transmits its GPS aircraft vector to air traffic controllers for display on the air traffic controllers' screen. However, Logsdon's discussion fails to provide any details of such a system or how it could be implemented. Furthermore, Logsdon's proposal does not address ground or surface detection of aircraft. Also, the Logsdon proposal fails to address the need for improved communication of information between aircraft and air traffic controllers, and the need for a technique to identify the aircraft that is communicating with the air traffic controller.

Brief Summary Text (14):
The foregoing demonstrates a need for an improved air and ground traffic control systems for aircraft. There is also a need for improved communication and exchange of information between aircraft and air traffic controllers, and a need for a system that allows controllers to verify the communicating aircraft. There is also a need for an effective navigation system that does not rely on VOR/DME stations, and for an aircraft landing system that does not rely on localizer and glideslope transmitters.

Brief Summary Text (17):
The ATC facility includes a transmitter and receiver for transmitting and receiving an information transmission (comprising data and other information) over the data link, a data decoder/detector for detecting data and communications in a received information transmission, a two way radio, an ATC computer for controlling operations at the ATC facility and identifying received data and communications, and a display for displaying the location and status of aircraft. Aircraft periodically transmit identification information, their GPS position, track, speed, and altitude, their status, and other information to the ATC facility. Based on this received information, the ATC facility continuously monitors and tracks aircraft. Because each aircraft transmits a different and predetermined identification, the ATC facility knows the identity of each target on the ATC controller's display. This system provides the additional advantage of allowing the ATC to accurately track aircraft without using radar, thereby avoiding the problems and disadvantages of radar, such as ghosts, limited range due to curvature of the earth and line-of-sight problems, etc. Furthermore, the tracking system of the invention may operate even in areas where no radar coverage is available. Also, the communication of requests, responses, information and data over a data link between aircraft and the ATC facility provides more accurate and complete communications than two-way radio, and avoids any miscommunications or misinterpretation of speech that commonly occur with two-way radio.

Brief Summary Text (18):
In addition, the aircraft unit also includes a transmit detector for detecting when the aircraft's two-way radio is transmitting. The ATC facility receives the transmit detect code along with the aircraft's identification via data link, thereby indicating when the aircraft's two-way radio is transmitting. This code may be displayed on the controller's display and allows the controller to identify or confirm exactly which aircraft on his screen/display he is communicating verbally over the two-way radio.

Detailed Description Text (13):
AARTS processor 28 is connected to a computer memory 30, which stores data and information. A data input device 38 may be used to input data, information, commands, communications into AARTS processor 28 for storage, processing or communication. Data input device 38 may include a code generator for generating specific codes that are input to AARTS processor 28 and which may be communicated via data link to the ATC facility 48. Alternatively, AARTS processor 28 receives information from input device 38 and generates codes to be communicated to the ATC facility 48. Data input device 38 is used by a pilot prior to or during each flight to enter information or special codes (i.e., emergency code, hi-jacker on-board code) identifying the aircraft into AARTS processor 28. For example, the identification code will be the aircraft's identification, tail or "N" number, airline flight number, or other code or number for identifying the aircraft. The type of aircraft will be indicated by the appropriate aircraft designator, such as B727 (Boeing 727), or C310 (Cessna 310). In addition, a special flight plan code for the type of flight plan and/or operation (VFR or IFR) and the type of aircraft is input. An "I" or a "V" is input to identify that the aircraft is operating under Instrument Flight Rules or Visual Flight Rules, respectively. The aircraft designator or identification code or other permanent information may be permanently stored in memory 40 to simplify or minimize the information that is input at the beginning of each flight into AARTS processor 28 using the data input device 38. In such case, a copy of the stored information is automatically copied from memory 40 into AARTS processor 28 (or RAM) at the beginning of each flight. In addition, speech recognition equipment may be connected to AARTS processor 28 to convert the pilot's verbal instructions into coded data that is input into AARTS processor 28, rather than having the pilot enter or type in the data using data input device 38. Display 39 is connected to AARTS processor 28 to provide visual information to the pilot and to allow the pilot to confirm the data or information that has been input using data input device 38.

Detailed Description Text (16):
A standard VHF two-way radio 44 is used by the pilot or co-pilot to communicate with ATC facility 48. As understood by those skilled in the art, other types of radios may be used. A transmit detector 46 detects when radio 44 is transmitting. The detection of transmission from radio 44 may be performed in a number of different ways. For example, transmit detector 46 may be connected to the microphone of the radio and detects whenever the microphone is keyed or actuated. Voice detection circuitry may be connected to an intercom box, or electronic circuitry may be connected directly to transmission circuitry of radio 44 to detect when radio 44 is transmitting. In response to detecting the transmission of information by radio 44, transmit detector 46 notifies AARTS processor 28 of the transmission from radio 44. Detector 46 may notify AARTS processor 28 of the detected transmission in a number of different ways. For example, detector 46 may generate an interrupt that is detected by AARTS processor 28, or detector 46 may change the logic value on its output line from a "0" to a "1" to indicate a transmission from radio 44. This output line may be monitored by AARTS processor 28, or the detector 46 may be frequently polled by AARTS processor 28 to determine when the radio is transmitting. As discussed below, the AARTS processor 28 communicates via data link to inform the ATC facility 48 of a detection of a transmission from radio 44 during the period that radio 44 is transmitting. In response to detecting a transmission from radio 44, either a code generator or AARTS processor 28 generates a predetermined code or symbol to be transmitted to the ATC facility 48 via data link during the period which radio 44 is transmitting. Preferably, this communication from AARTS processor 28 informs the ATC facility 48 of the transmission from radio 44 and causes equipment (i.e., a display) at the ATC facility 48 to generate the predetermined symbol.

Detailed Description Text (23):
An ATC computer 66 receives information and data from ATC receiver 60, and outputs

data and information to ATC transmitter 61. ATC computer 66 includes one or more processors (not shown) and a computer memory (not shown) for storing information and data received and other information. ATC computer 66 controls the overall function and operation of the ATC facility 48. GPS receiver 67 (or multiple GPS receivers) provide GPS data of the ATC facility 48 to ATC computer 66. ATC video processor 68 generates the symbols or graphics to allow the display of aircraft, aircraft location, altitude, speed, status, etc. based on information received from the ATC computer 66 and information received via data link. ATC display 70 selectively displays certain aircraft and selected information about each aircraft under control of video processor 68 and/or ATC computer 66.

Detailed Description Text (30):
The air traffic controller may be notified of the computer calculated new route or heading, altitude, speed, etc., for an aircraft and asked to acknowledge that such new course is acceptable prior to transmission from the ATC facility 48 to the aircraft. Alternatively, the air traffic controller may simply be notified of the aircraft's new course after it has been communicated to the aircraft. ATC computer 66 may communicate via transmitter 61 information such as the aircraft's location, altitude, heading or tracking, speed, aircraft status, closest aircraft, to the aircraft to allow the aircraft to verify that the ATC facility 48 has correct information. Also, ATC computer 66 may also transmit such information to other aircraft in the area to allow such aircraft to be aware of other aircraft that are nearby. To direct the information transmission from the ATC facility 48 to the correct aircraft, each information transmission may include a header segment that identifies the aircraft (by registration number, flight number, etc.), and an information segment that includes information, messages, or instructions. The transmissions from the aircraft should also follow this same format. The information transmitted between the ATC facility 48 and aircraft, and between aircraft, may include a wide variety of types of data and information, such as aircraft location, speed, altitude, tracking, aircraft status, inquiries to the aircraft pilot, responses to inquiries, instructions or commands to the aircraft from the ATC facility 48, information regarding the aircraft that are nearby, and other types of information discussed herein. This information is received by an aircraft and may be displayed on the aircraft's display 39 (FIG. 1) as text, graphic symbols, or other indicia. Alternatively the information may be in the form of synthesized voice or digitized speech generated at ATC facility 48, communicated to the aircraft via data link, and output to the pilot headset or a speaker. The information may be transmitted from the ATC facility in coded form and output as synthesized voice or speech on the aircraft. The pilot may respond to such inquiries or input new information to be transmitted to the ATC facility 48 or another aircraft via data input device 38 or by speaking into a microphone. Well known speech recognition equipment and software may interpret voice signals at both the ATC facility 48 and the aircraft and convert such voice signals into text or information prior to transmission.

Detailed Description Text (31):
ATC video processor 68 generates the graphics and text to illustrate the location of each aircraft on ATC display 70. ATC display 70 displays to the air traffic controller a pictorial or graphic representation of specified aircraft, their locations, status, headings, and other information in text or graphics based on information on the aircraft stored at and received by the ATC computer 66. Alternatively, the function of ATC video processor 68 may be performed by computer 66. Each air traffic controller should have his/her own display 70. Each ATC display 70 may have a separate video processor 68. ATC computer 66 may include a single computer, or may comprise a plurality of computers, where incoming information transmission and data therein are identified and forwarded to the appropriate computer. Aircraft display 39 (FIG. 1) may also include a video processor and a display for generating and displaying similar types of information to the pilot.

Detailed Description Text (32):
ATC computer 66 processes the incoming data for display. Computer 66 preferably identifies each received data. Each data may include, for example, an aircraft registration number, GPS position, GPS altitude, GPS speed, aircraft status information, messages of communications to and from aircraft, etc. There are a plurality of data in an information transmission, each information transmission including a header segment and an information segment. After detecting and/or identifying the data in the information transmission, ATC computer 66 processes the data. Such processing may include a number of different tasks, such as notifying the air traffic controller of the received data (by audible or visual display or annunciator) and identifying the associated aircraft, and making information about each aircraft available to the air traffic controller. ATC computer 66 selects and displays targets (aircraft) on a controller's display 70 based on the controller's assigned sector and altitude (i.e., north sector, 10,000-23,000 ft. alt.). Inhibit functions may be programmed into computer 66 such that the aircraft are displayed on the (each) display 70 for the appropriate controller. Some overlap may occur to ensure proper tracking of aircraft passing from one sector to another. The ATC computer 66 models the path of all detected incoming aircraft and displays (via display 70) these aircraft along with selected information on each aircraft. ATC computer 66 also displays any untagged aircraft (aircraft that transmit only "1200" (VFR) on a transponder code, and/or transmit no identification code via other communications or data link).

Detailed Description Text (33):
Display 70 may be a conventional radar scope, a dedicated CRT display, or other display. Selected information on each aircraft on the radar screen are displayed in the flight data box 71. Information displayed in the flight data box 71 may include:

Detailed Description Text (45):
While all this information may be displayed in each flight box 71 on display 70, it is advantageous to display only selected information (such as the information shown displayed in FIG. 2) in each flight box 71, while allowing the air traffic controller to "click" or select on an aircraft using a mouse, trackball or other pointing device to cause the remaining information on the selected aircraft to be displayed in text or graphical form on another screen, window, or another display. For example, information such as the aircraft's heading, identification or flight number, aircraft type, altitude and/or location, and an indication that the aircraft's radio is transmitting (T) may be displayed in flight box 71, with the remaining information on the selected aircraft available on the second screen or display. By displaying only selected information on display 70, the air traffic controller is allowed to quickly view many different aircraft on display 70 while still having access to more detailed or additional information by selecting an aircraft using a pointing device.

Detailed Description Text (47):
Prior to a flight, the pilot registers the aircraft and its flight plan with the ATC facility 48. Computer 66 stores information on the identification of the aircraft, the aircraft flight plan, and other information. Prior to take-off, the flight plan and other information for each aircraft may be transmitted via data link (satellite, VHF/UHF, cellular telephone, etc.) from the ATC facility 48 to the aircraft unit 18. AARTS processor 28 receives the information and downloads (stores) this received information in memory 30. Also, various communications may occur between aircraft and the ATC facility 48 prior to aircraft take-off, such as to confirm the flight plan, etc. The flight data box 71 of display 70 displays a variety of information to the air traffic controller regarding each aircraft in his/her assigned sector and altitude range. As discussed above, the information displayed to the controller on the display 70 may include aircraft identification, speed, heading, altitude, and notification as to the status of the aircraft. The GPS data is input into AARTS processor 28 from comparator 24 and is continuously

updated.

Detailed Description Text (48):
While in flight, the aircraft may communicate with ATC facility 48 via two-way radio 44. In addition to using two-way radios, the aircraft and the ATC facility 48 may communicate with each other over an additional communications link (i.e., a data link) using transmitter 61 and receiver 60 of the ATC facility and transmitter 32 and receiver 33 of the aircraft. In particular, AARTS processor 28 periodically communicates via transmitter 32 and receiver 60 over a data link (preferably satellite communications) to transmit the GPS data of the aircraft, aircraft identification, status of the aircraft, and other information to the ATC facility 48. Upon receipt of the transmitted data at ATC facility 48, computer 66 processes the data and then displays the data on the display 70. The data displayed on display 70 allows the air traffic controller to keep track of and control aircraft in his/her assigned sector and altitude range.

Detailed Description Text (49):
When a pilot on an aircraft transmits information using his two-way radio 44, transmit detector 46 detects the transmission of information from radio 44. AARTS processor 28 is informed of the transmission from radio 44 and controls transmitter 32 to transmit additional data notifying the ATC facility 48 that the aircraft is transmitting over its two-way radio. AARTS processor 28 preferably generates a code (a radio transmit detect code) that indicates a radio transmission from aircraft radio 44. This transmit detect code is preferably a T or (T), although a wide variety of symbols could be used. The transmit detect code, or information representing this transmit code, is then encoded as a series of bits, modulated and transmitted to ATC facility 48. The receiver 60 of ATC facility 48 receives, demodulates, and decodes this transmit detect code. ATC computer 66 recognizes this transmit detect code and instructs symbol generator to generate the (T) symbol and output this (T) symbol to display 70 adjacent the other information in the flight box 71 for this aircraft. The aircraft identification information (transmitted with the transmit detect code) identifies the specific aircraft to which the (T) symbol corresponds. The (T) symbol indicates that the identified aircraft is presently transmitting via two-way radio. This (T) symbol makes it very easy for the controller to determine what aircraft with which he is communicating via 2-way radio, and allows the controller to more easily confirm that the correct aircraft is responding to his/her instructions.

Detailed Description Text (50):
When the transmission from radio 44 is complete, transmit detector 46 detects that radio 44 is no longer transmitting, and notifies AARTS processor 28 that the transmission has terminated. AARTS processor 28 then instructs transmitter 32 to cease transmitting the transmit detect code (T). ATC computer 66 then fails to receive the (T) code from receiver 60 and in response, instructs symbol generator 68 to cease generating the (T) code for display. The result is that only when the pilot is speaking on his two-way radio 44, a (T) symbol is displayed on the controller's display 70.

Detailed Description Text (55):
The ATC facility 48 receives the information transmission from each aircraft, and ATC computer 66 identifies each aircraft, and displays the aircraft or a symbol representing the aircraft, its location on a display at the ATC facility 48. ATC computer 66 identifies the aircraft using the received identification information. Because each aircraft transmits its location and a different predetermined identification code (known by ATC computer 66), each aircraft is effectively "tagged," allowing the identity and location of each aircraft to be ascertained by computer 66. The surface movement and detection system also includes a mapping system (i.e., software) resident in ATC computer 66 that maps the different airport structures, including airport ramps, taxi ways, runways, hangars, buildings, etc., and is programmed with the GPS coordinates of the location of each of these airport

structures, so the relative location of each aircraft on the ground may be determined by ATC computer 66. ATC computer 66 may display all structures on the airport (runways, taxi ways, buildings, etc.), or just selected ones at the request of the air traffic controller. The surface movement and detection system may use the same display (70) as used for the tracking of aircraft while in the air, or may use a separate display. ATC computer 66 keeps track of all aircraft on the ground, including their locations and status.

Detailed Description Text (56):
Tracking and coordination of aircraft on the ground is enhanced by each aircraft transmitting a transmit detect code to the ATC facility 48 when the pilot on the aircraft is communicating (transmitting) using his two-way radio 44, as discussed hereinabove. The transmit detect code is accompanied by the aircraft's identification information. This information is received by the ATC facility, and a predetermined symbol, such as a T or a (T) is displayed at display 70 (or other display) to indicate reception of the transmit detect code. The display of the predetermined symbol (T) indicates to the air traffic controller that the pilot is transmitting on his two-way radio 44. This transmit detect code and aircraft identification information allows the controller to determine which aircraft on his display he is communicating with over his two-way radio. This information also allows the controller to verify that when he communicates an instruction to a designated aircraft (i.e., you are clear to take off), only that designated aircraft responds to that instruction.

Detailed Description Text (60):
In differential navigation, two GPS receivers continuously exchange navigation information with one another in real time. One of the GPS receivers (67) acts as a base station; The other GPS receiver (20 or 22) navigates relative to the base station's location. The base station (ATC facility 48) determines its real-time pseudo-range solution based upon the received binary pulse trains (pseudo-range=C.times.delta T). Because the base station also knows its exact location, it also determines a real-time geometrical solution (geometrical range=satellite position-base station position). The base station then calculates a pseudo-range correction by subtracting the geometrical range from the pseudo-range. This pseudo-range correction is periodically calculated and transmitted to all GPS receivers (20 and 22). GPS receivers located on aircraft (on ground and in air) may subtract this correction from their calculated pseudo-ranges to obtain GPS position, altitude, speed, and track that are much more accurate. The GPS resident processor of GPS receivers 20 and 22, and/or AARTS processor 28, and ATC computer 66 are programmed with software, using well known techniques, for performing the appropriate calculations and communications of pseudo-range corrections and other data. While the pseudo-range errors may be transmitted from the base station (ATC facility 48) to all aircraft, it is preferable that ATC computer 66 receives the uncorrected GPS data from each aircraft, and then performs this subtraction or adjustment of the received aircraft GPS data using the pseudo-range correction prior to displaying aircraft and their position on the ATC display at the ATC facility 48. Thus, using differential navigation, the GPS position calculated by each aircraft is transmitted to the ATC facility 48, and the ATC computer 66 subtracts the pseudo-range correction to obtain the corrected position of each aircraft.

Detailed Description Text (64):
Also, information regarding other status of the aircraft may be communicated to ATC facility 48 prior to take-off. The flight plan or other information may be communicated from the ATC facility 48 to the aircraft unit 18 and stored in memory 30 of aircraft unit 18. Aircraft unit 18 may communicate via data link to ATC facility 48 to verify or confirm specific information, such as the flight plan, flight instructions, departure runway, etc. Display 39 may display, in graphical, text or other form, the planned flight plan, or the planned and approved/proposed flight route and other information for review and confirmation by the pilot. The

pilot or crew may input information into AARTS processor 28 using data input device 38, which may include a keyboard, keypad, a series of buttons or switches, a microphone, etc. This information input by the pilot may be communicated to ATC facility 48 via data link (satellite, cellular, VHF/UHF, etc.), either automatically after being input, in response to actuation of a switch, or in response to another event. The ATC facility 48 may transmit questions or responses which are displayed to the pilot on display 39 in the form of text or graphic symbols. The aircraft unit 18 may also transmit questions and responses to ATC facility for display.

Detailed Description Text (65):
Prior to take-off, aircraft unit 18 may transmit information via data link to the ATC facility that it is ready for take-off, and the ATC facility may respond with appropriate instructions (i.e., that the aircraft is clear to take off and designation of the runway to be used). While such communication normally occurs verbally between aircraft and the air traffic controller using two-way radios 44 and 52, the invention allows such verbal communications process to be replaced or at least supplemented by the transmission of coded signals and/or data that are transmitted via data link (satellite, HF, VHF, UHF, cellular, etc.) and displayed to improve the communications process and the accuracy of information communicated. Aircraft that have just landed may receive via data link instructions of where to taxi, and whether the terminal is accessible, or open, etc. After landing, the aircraft unit 18 may communicate a request via data link to close the aircraft's flight plan to ATC facility 48. The request may be made manually by the pilot actuating a switch or by inputting a predetermined instruction or code using input device 38, or the request may be generated automatically in response to the landing of the aircraft, the lowering of the landing gear, in response to interrogation from the ATC facility 48, or in response to some other event.

Detailed Description Text (67):
FIG. 2 illustrates a flight control system 72 located on an aircraft for automatically controlling the flight of the aircraft. A flight control computer 74 controls all operations and functions of the flight control system 72. Flight control computer 74 receives GPS data from GPS receivers 20 and 22 through GPS data comparator 24. The flight control computer interfaces to a number of aircraft systems 78, such as electrical power, fight management system, inertial reference system (IRS), air data system, radio altimeter, instrument landing system (ILS), central warning system, etc. An input device 76 may be used to input data and information into computer 74, and a screen or display may display information and data. The display may provide annunciators for indicating to the pilots the activation/selection of the various flight modes and systems (autopilot, heading select, VOR, etc.). A flight control panel 80 provides the primary interface between the fight crew and the other components of the flight control system. The control panel 80 includes a number of pushbuttons that provide momentary discrete inputs to the flight control system. The pushbuttons provide four categories of control: 1) combined control (autoland, ILS, Turb, VNAV), 2) pitch control (vert. speed, altitude hold), 3) Roll control (VOR Location, Heading hold, heading select, Nay), and 4) Autothrottle control (speed select, mach select). The panel also includes an autopilot engage switch for engaging the autopilot, and a switch for selecting autoland. Next to the autoland switch is a switch for selecting the autoland to be performed based on ILS or based upon GPS data. A number of control knobs and displays are also on the control panel 80, including altimeter knob (for dialing in a desired altitude), heading knob (for dialing in a desired heading, etc. A number of digital display readouts are also provided on the control panel 80, including displays for: airspeed (knots), heading (magnetic heading displayed in degrees), altitude, pitch (vertical airspeed, mach value, pitch attitude).

Detailed Description Text (74):
Computer 74, however, preferably uses the differential GPS data, including pseudo-range corrections from facility 48, to land the aircraft. The computer 74 stores in

memory, or receives via data link from ATC facility 48, information on the location of the airport, locations and dimensions of all structures at the airport, including runways, taxiways, buildings, terminals, and the direction from which the aircraft should approach each runway for landing. Based on this information describing the layout and structure of the airport, the computer 74 may display on a screen or display a picture or graphical image of the layout of the airport with designation as to the route or path to use for landing, the runway to use, the location of aircraft on the ground.

Other Reference Publication (30):
Trimble Navigation (Sunnyvale, California), "Starview Tracking and Display Station", undated, 1 page.

CLAIMS:

2. The method of claim 1, said method further comprising the step of displaying one or more visual symbols identifying the vehicle and indicating when the vehicle is transmitting the information based on said step of identifying.

12. The method of claim 11, said method further comprising the step of displaying one or more visual symbols identifying the vehicle and indicating when the vehicle is transmitting the information based on said step of identifying the period of time.

13. A method of identifying an aircraft transmitting information using a second transmission, said method comprising the steps of:

storing on the aircraft an aircraft identification code identifying the aircraft;

transmitting information from a radio on the aircraft;

automatically detecting, on the aircraft, said step of transmitting the information;

automatically detecting, on the aircraft, when the aircraft radio ceases transmitting the information;

generating on the aircraft a transmit detect code in response to said step of automatically detecting the transmission of the information;

transmitting from the aircraft said second transmission, said second transmission comprising the aircraft identification code and the generated transmit detect code, the transmit detect code being transmitted, based on said steps of detecting, only while the aircraft radio is transmitting the information;

receiving the information, the aircraft identification code and the transmit detect code transmitted from the aircraft;

identifying that said aircraft is the source of the transmitted information based on said received aircraft identification code and the received transmit detect code;

identifying when said aircraft is transmitting the information based on the presence or absence of said received transmit detect code; and

displaying visual indicia or symbols on a display based on said steps of identifying, said visual indicia or symbols identifying the aircraft, identifying the aircraft as the source of the information transmission, and identifying when the aircraft is transmitting the information.

16. The method of claim 15 wherein said step of displaying further comprises displaying a symbol or indicia on the display designating the location or having a location based on the received aircraft location.

18. The method of claim 17 wherein said step of displaying comprises the step of displaying a visual symbol or symbols on an air traffic control display.

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